NOTES ON THE HUMAN BRAIN

The brain consists of 100,000,000,000 (10^11, ie, 100 billion) or more neurons (as well as many other cells). Most of these neurons are contained in the neocortex which is found in mammals; it wraps around a smaller and evolutionarily older part of the brain sometimes called the "smell brain", "crocodile brain", or "reptile brain".

The rough outline of the brain seen from the left is:

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         ------------------
        /      */#         \
f      /   F  */#  P      / \
r     /______*/#_________/   \
o             _-         (  O  )
n           /      T     \   /
t          /______________\_/
                    \    c  )
                     \   __)
                      \ \
```

Fig 1

where F = frontal lobe, P = parietal lobe, T = temporal lobe, and O = occipital lobe. The lower tip of the smell brain is just visible below the temporal lobe, where it joins the spinal cord; also visible is a bit of the cerebellum, c.

From the top:

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            -----------------------
           /                       \
          |                         \
f         |                         /
r          \_______________________/
o           _______XXXXX___________
n          /                       \
t         |                         \
          |                         /
           \_______________________/
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Fig 2

The top view shows that the brain (neocortex) comes in two very similar "hemispheres", left and right, each of which look like Fig 1 above when seen from the side. Thus there are two frontal lobes, two parietal lobes, etc. The two hemispheres are connected by a thick band of axon fibers XXXXX called the corpus callosum.

The strip *** along the back edge of F, and the strip ### along the front edge of P, are called the motor strip and the somatosensory strip, resp. The motor strip consists of neurons whose signals proceed down the spinal cord to muscles, causing them to contract; the frontal lobes (left and right) are thought to be involved in planning, and thus it seems not unreasonable that motor commands (enacting a plan) would emanate from there. The somatosensory strip receives sensory signals traveling from the body up through the spinal cord and smell brain and other inner structures and into the parietal lobe.

A striking feature is that of the "crossed" brain: all of the motor and sensory signals that travel to and from the brain via the spinal cord cross over to the opposite side. That is, the left half of the body (below the neck) is connected (both for sensory and for motor signals) to the right side of the brain, and vice versa.

The two eyeballs are situated just under the left and right frontal lobes. The "crossing" situation for vision is more complicated than for the motor and somatosensory strips just mentioned. Each eye (at the back, or retina) sends via its light-sensitive neurons (rods and cones) signals to either the right or left occipital lobe, depending not on which eye but rather on whether the light comes from the right or left of center of gaze. That is, half of the retina in each eye projects to the left occipital lobe, and half to the right occipital lobe. Specifically, light from the right of center falls on the left half of the retina in each eye, and then signals are sent from there to the left side of the brain, and similarly for the right. (However, the corpus callosum transmits this information from each side also to the other side.) Destruction of, say, the left occipital lobe, results in complete loss of visual awareness of the right visual field, and vice versa.

It is known that the occipital lobe performs only the "early" visual processing, such as edge orientation, and that this information in turn is passed to other areas such as the temporal lobe where a presumed (but ill-understood) process of integration occurs, affording high-level determination of what is seen (eg, a house or a face). The temporal lobe is also involved in memory and in processing of auditory information. The parietal lobe is thought to process highly abstract ideas such as mathematics.

Overall, however, although many volumes of detailed information about the brain is well estrablished, how it manages to do what it does is still in many respects uncertain. Even vision, the most heavily studied brain function, remains cloudy in at least one fundamental respect: at what point, and as part of what process, does visual awareness (actual subjective experience of seeing) occur? Not only is this not known, but no one has even managed to formulate a clear guess as to what it could be. The easiest notion to form (and then reject!) is that some sort of image is created in the brain, a bit like a TV set (but then "who" is looking at it?).

Now let us return to individual neurons. A neuron is a highly specialized cell, with the usual cell body with its nucleus as well as a long "axon" that acts a bit like a current-conducting wire. The axon usually splits into many "tips" that can come close to other neurons.

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                                               |       |
                                       -----   |       =====
     ----------                       /        |_______|
    |          |               /  __/        ^      another neuron
    |          | signal -->   /  /        synapse
    |          ====================
    |          |    axon       \   \
    |__________|                |   \__

     cell body
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When the proper electro-chemical conditions occur in the cell body, an electrical current ("action potential") is initiated there, which travels from the cell body all the way along the axon to the axonal tips where it causes molecules known as neurotransmitters to be released. If there is another neuron close enough, some of the neurotransmitters will come into contact with it. This close proximity that allows such contact is called a synapse. A synapse can be such that, when the neurotransmitter makes contact, the contacted cell becomes more likely to fire (excitatory synapse) or less likely (inhibitory synapse).

The cerebellum (c,in Fig 1) consists mostly of inhibitory synapses, which seems not unreasonable given that its apparent function is to provide fine motor control (as in piano-playing or reaching for something); damage to the cerebellum leads to loss of this control so that motions tend to be exaggerated as in overreaching.

One neuron may, on average, be connected to (have synapses with) as many as 5000 others.